A VACUUM SYSTEM FOR HANDLING CHICKEN HATCHERY WASTE

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A VACUUM SYSTEM FOR HANDLING CHICKEN HATCHERY WASTE

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ABSTRACT

A vacuum waste-handling system was designed, built, and installed in a commercial chicken hatchery. In 8 months of operation, the system reduced labor requirements and reduced the volume of waste output over 80% by compacting broken eggshells. It also reduced truck mileage for waste disposal by more than 50% and permitted the truck to be available for other activities during the day. **KEYWORDS: chicken hatchery waste, pneumatic waste-disposal systems, waste disposal.**

INTRODUCTION

Approximately 3.8 billion chicks are produced in the United States each year for meat and egg production.[2] Assuming an average hatch rate of 85%, 4.5 billion eggs would have to be incubated annually to reach this output, and the hatchery waste would include 57 million pounds of shells and 83 million pounds of unhatched eggs.

Removing waste from hatcheries and disposing of it are major problems in the poultry industry. In this study, as waste accumulated, it was manually dumped from trays into a dump truck, where it was exposed to the sun or rain for 6 hours or more before being covered with a tarpaulin and transported to a county-owned landfill. Enroute to the landfill the truck often lost some of the liquid waste, posing a public nuisance and possible health hazard. Moreover, such an operation is costly, and it is becoming extremely difficult to obtain permission to dispose of hatchery waste at county-operated landfills.

Processed hatchery waste has potential as a feed supplement, since it is approximately 25% protein (see footnote 2) and a good calcium source. An improved handling and storage system could conceivably make transporting and selling it to a central rendering plant an economic operation. The objective of this work was to develop a system for pneumatic handling, compacting, and storage of hatchery waste and to test its commercial feasibility. A vacuum system was designed and installed in a hatchery that hatches approximately 55,000 birds per day. Assuming an 85% hatch, approximately 55,000 shells and 10,000 unhatched eggs ------ be discarded each day. The system was d to handle approximately 2,400 pounds, cubic feet, of uncompacted waste per da

EQUIPMENT

Any pneumatic waste system incor three major components (fig. 1): (1) a for dumping and feeding waste into th (2) a pump, or blower, to provide the f transport the waste; and (3) a recei separate solids from air and store the until it is dumped. The only other requi is ductwork to connect the major compon

Hopper.—The hopper (fig. 2) is 52

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[2] Richard March and Gerald K. O'Mara. The feasibility of recycling hatchery waste for feed. Working paper. Commodity Economics Division, Economic Research Service, U.S. Department of Agriculture.

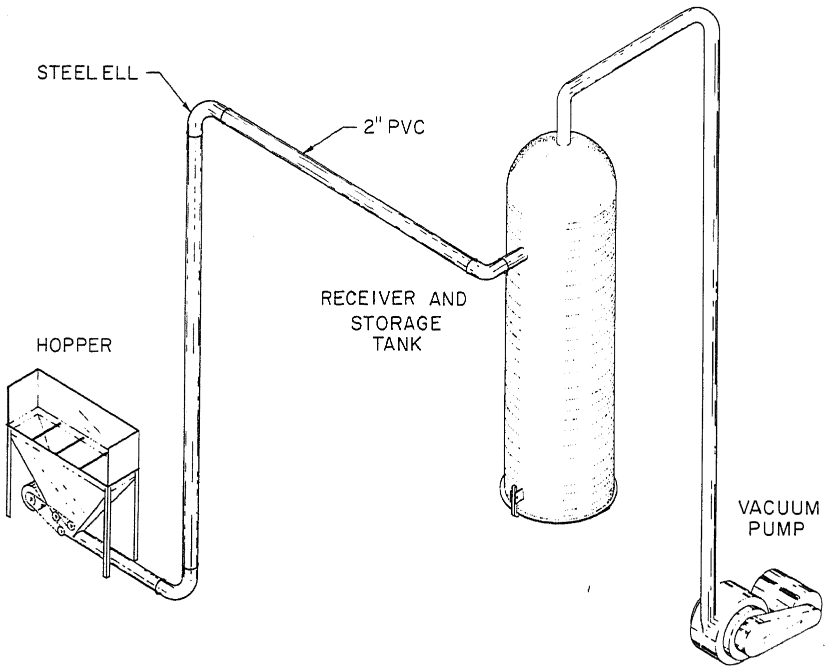

FIGURE 1.—Vacuum system, showing the three major components.

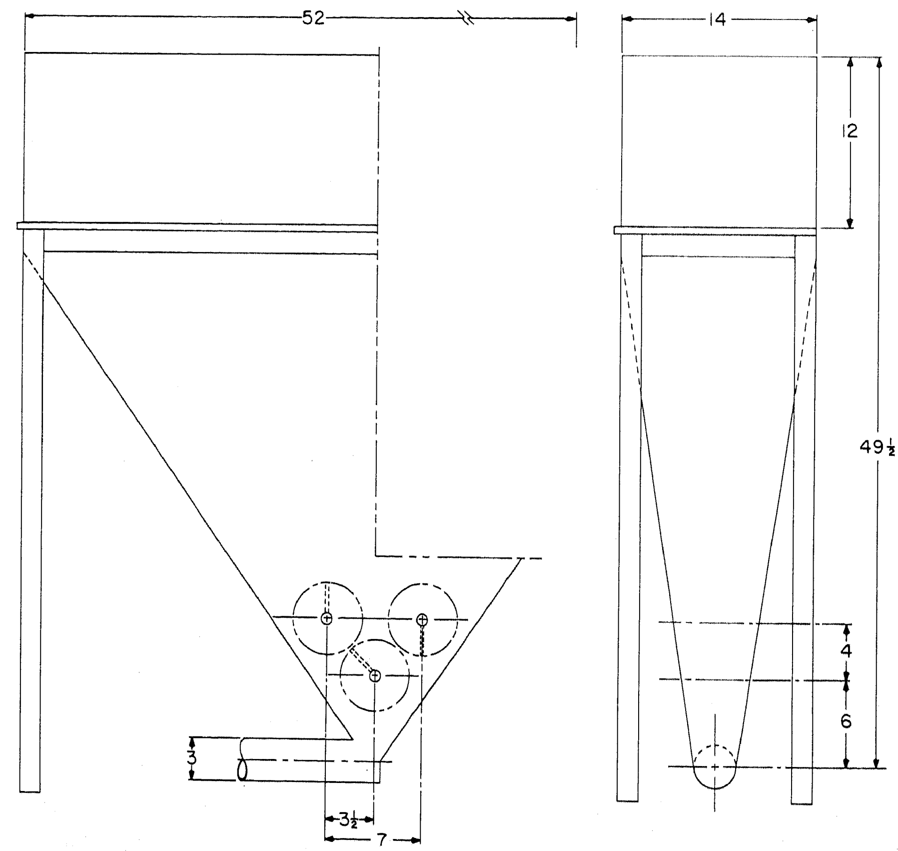

FIGURE 2.—Details of hopper. Dimensions are in inches.

long, 14 inches wide, and about 49½ inches high. The opening at the top is 14 by 52 inches, which is slightly larger than the standard hatchery trays from which the waste is dumped. The sides taper down to a bottom opening about 3 by 3½ inches. Three mechanical agitators in the bottom of the hopper prevent waste from bridging across the opening. The agitators consist of three horizontal shafts with three, four, and five irregularly spaced metal fingers 2½ inches long that protrude perpendicularly from the shafts. The shafts are chain-driven by a ⅓-horsepower electric motor and are counterrotating at approximately 58 revolutions per minute. The agitators also act as a feeding mechanism, which helps prevent line stopup.

Pump.—Laboratory tests were run to determine critical design specifications such as line size and air velocity. A 2-inch line is adequate if an air velocity of 6,000 ft/min is used. A 150-ft^3/min vacuum pump with a 10-horsepower electric motor powers the system. The pump produces a velocity of 6,330 ft/min at 3 inches of mercury vacuum, which is equivalent to 138 ft^3/min. Various controls insure the safety and proper operation of the pump, including a flow switch, a solenoid valve, a pressure regulator, and a trap filter.

Receiver and storage tank.—The receiver is constructed from a 330-gallon butane tank 2½ feet in diameter and approximately 9 feet long. The bell shape from one end of the tank has been removed and a 1½-inch flange welded on. (This is the bottom of the receiver.) A trapdoor provides a proper seal and facilitates dumping (fig. 3). The tank has an approximate capacity of 34 cubic feet of waste.

The trapdoor is constructed of ¼-inch steel plate with 1½-inch angle iron and 2-inch T-stock to add rigidity. Hinges with screw adjustments

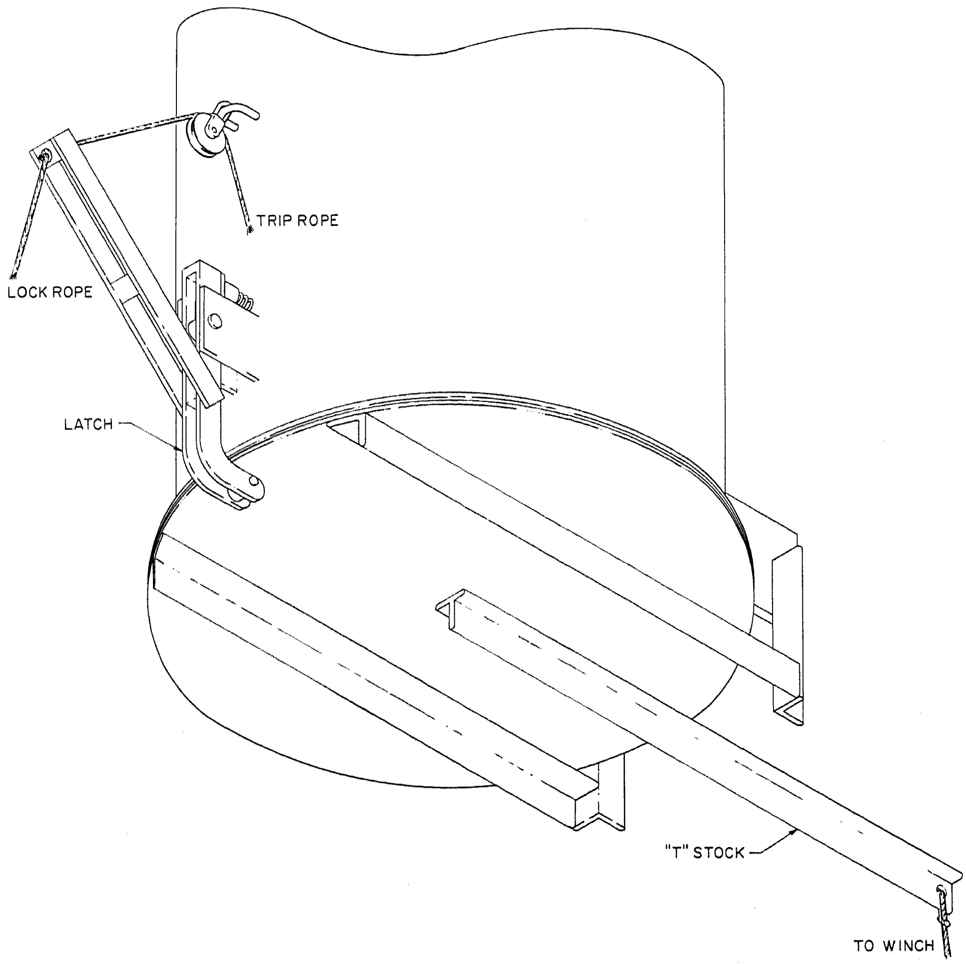

FIGURE 3.—Bottom view of receiver.

(fig. 4) allow the door to close securely and seal properly. Screw adjustments on the latch insure a proper fit (fig. 5). To assist in sealing, which is of utmost importance, a tubular rubber gasket is riveted to the iron flange on the bottom of the tank.

Opening and closing of the door is done by the quick-trip latch, pulleys, and a small hand-operated winch. A winch cable is connected to the T-stock, which is the center brace on the door, and extends 20 inches past the rear of the door (fig. 3). To open the door, the winch is simply placed in the free-wheel position and the trip rope pulled. To close the door, the

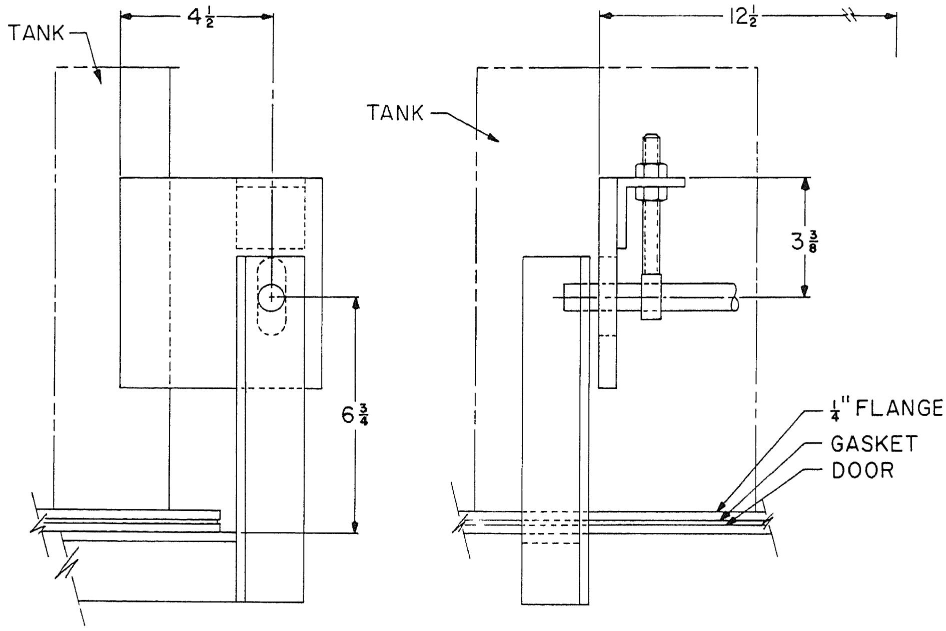

FIGURE 4.—Hinge details of receiver door. Dimensions are in inches.

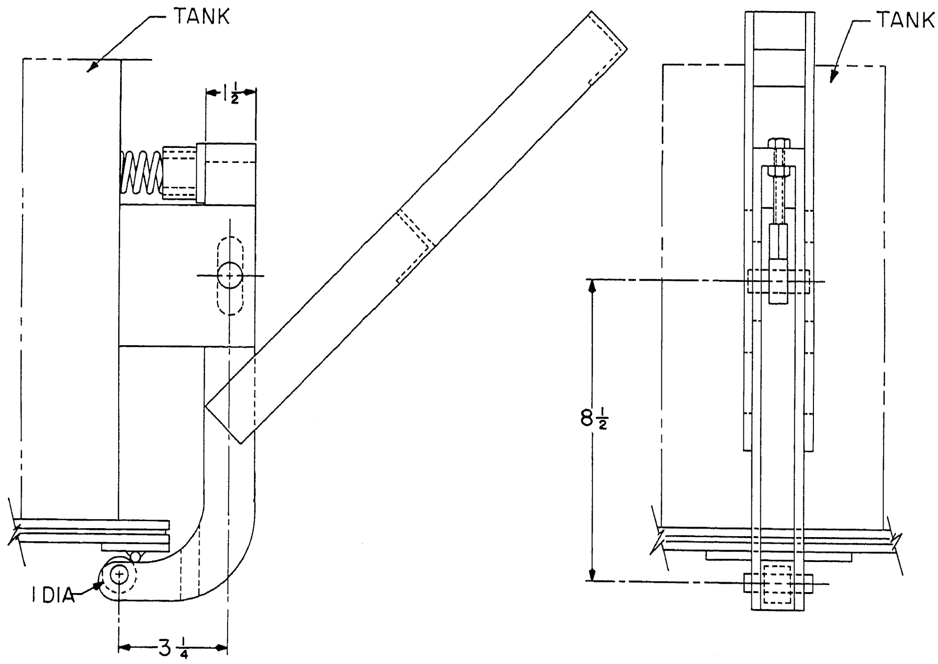

FIGURE 5.—Latch details of receiver door. Dimensions are in inches.

winch is locked in the takeup position and cranked up. When the door is firmly closed, another rope opposite the trip rope is pulled down, locking the latch in place; then tension is let off the winch and cable.

A washdown nozzle is installed in the top of the tank. The nozzle assembly is equipped with a ¾-inch faucet to provide easy hookup plus a secure seal to keep from losing vacuum during operation.

OPERATION

In the commercial installation the receiver, or storage tank, was installed outside the hatchery (fig. 6) and because of the system of removal, it had to be suspended 10 feet above ground. Scaffolding supporting the tank was constructed 12 feet wide by 6 feet deep so that a dump truck could be backed underneath to receive waste from the tank. For test purposes the vacuum pump was installed on a trailer and positioned adjacent to the tank outside the building. In a permanent installation the vacuum pump should be located inside the building. The hopper was placed inside the hatchery between the tray chute (slide) and the tray washer (fig. 7).

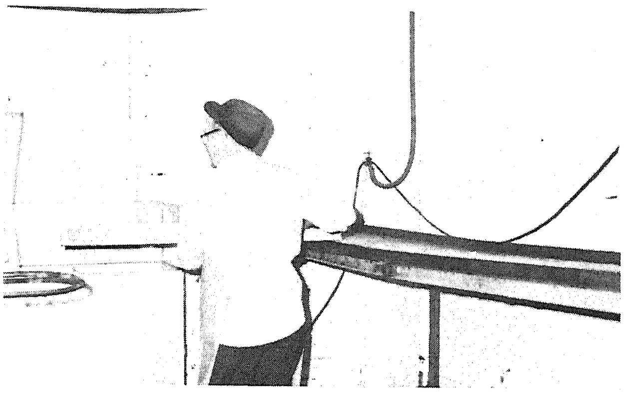

FIGURE 7.—Transferring waste from tray slide to hopper.

During hatchery operation the vacuum pump runs continuously, maintaining a constant airstream through the system. After chicks are removed from trays, the trays are placed on the chute and move by gravity to a position alongside the hopper. A worker removes trays from the chute and manually dumps the waste into the hopper (fig. 7). Empty trays are hung on the tray washer and cleaned for reuse.

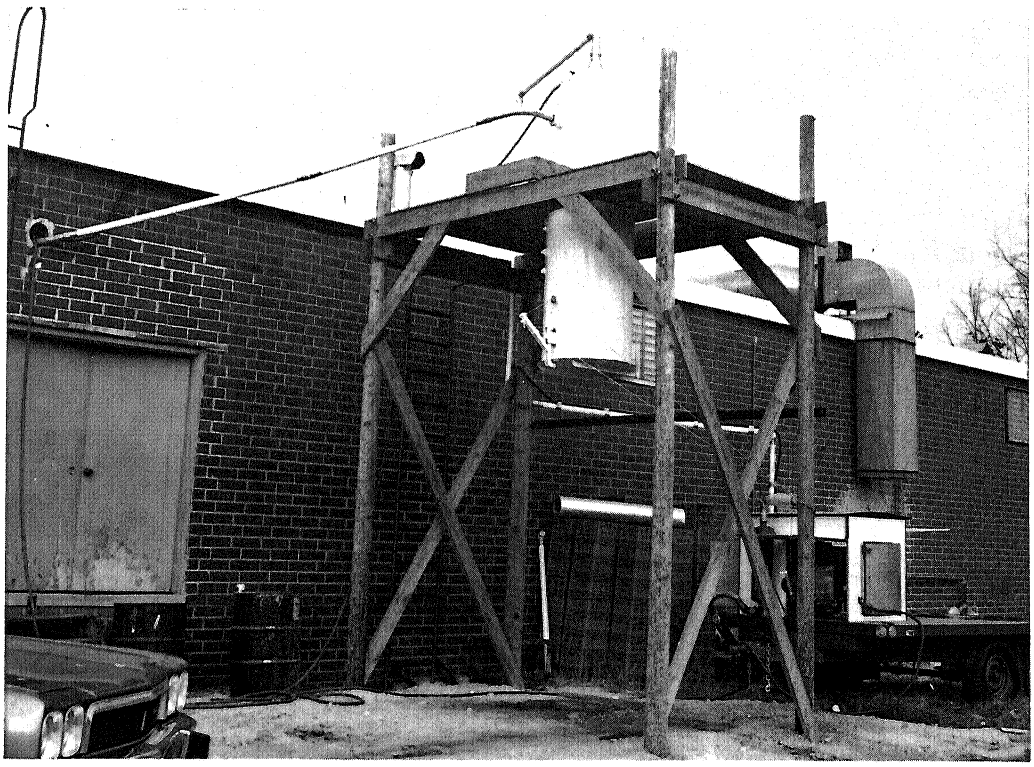

FIGURE 6.—Tank and dumping platform.

FIGURE 8.—Worn polyvinyl chloride elbows.

Waste accumulates in the hopper and agitators feed it at a constant rate into the polyvinyl chloride (PVC) line at the bottom. It is pulled through the line to the receiver, where solids are separated from the air and drop to the bottom of the tank. The storage tank holds the waste from more than a full day's run.

At the end of the shift the pump is cut off, releasing the vacuum in the system. The dump truck is backed into position underneath the tank. The trapdoor in the bottom of the tank is released, and the waste drops into the truck. The tank is then cleaned.

EVALUATION

The system was evaluated under commercial operating conditions for 8 months. Three problems were encountered:

1. During the first day of operation waste packed up and would not pass through the 2-inch PVC line connecting the hopper and receiver. A section of 2½-inch PVC, about 5-feet long, was connected to the bottom of the hopper. This permitted the waste to build up momentum before entering the 2-inch line and eliminated clogging.

2. Initially, all piping was PVC, and the abrasive eggshells wore holes through the elbows in less than 2 days (fig. 8). Rigid 2-inch metal conduit formed into sweep elbows solved the wearing problem and also increased the velocity of waste moving through the line by increasing the radius of all turns in the line. The eggshells proved to be useful as well as harmful: their abrasive action kept the line clean of waste buildup.

3. When hatch dropped below 82%, the line clogged up where it made its vertical ascent. This was eliminated by reducing the angle of lift from 90° to 45°, allowing only a 50% energy loss instead of the 100% loss in making a horizontal to vertical turn. After this modification, the system operated well even when hatch fell as low as 70%.

After these modifications had been made, the equipment operated satisfactorily. The system is commercially feasible. It reduces labor for cleanup and transportation, and compacts the volume of waste by over 80%. In the hatchery studied, mileage for transporting waste was reduced by more than 50%, and the truck's availability was increased for other uses. Adoption of the system by industry could significantly reduce the cost of waste handling.

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